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Biomass energy in Vojvodina: Market conditions, environment and food security

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ABSTRACT

In this study, the policy, market conditions and food security of biomass energy sources are assessed for supplying the future needs of Vojvodina. The Autonomous Province of Vojvodina is an autonomous province in Serbia, containing about 27% of its total population according to the 2002 Census. It is located in the northern part of the country, in the Pannonia plain, in southeastern Europe.

Vojvodina is an energy-deficient province. Vojvodina also has a large potential for renewable energy, especially energy from biomass (biodiesel and bio-ethanol). The lack of knowledge about renewable energy technologies by most policy-makers, potential consumers, and energy firm managers has played against renewable energy developments. The environmental impacts of programs that encourage biofuel production, farmland land requirements and the impacts on food production are also discussed, considering the life cycle analysis (LCA) as a tool.

It is concluded that the rise in the use of biofuels is inevitable and that international cooperation, regulations and certification mechanisms must be established regarding the use of land, the mitigation of environmental and social impacts caused by biofuel production. It is also mandatory to establish appropriate working conditions and decent remuneration for workers of the biofuels production chain.

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Contents

1. Introduction

Energy is one of the most important inputs in the process of development. Although extensive studies on energy production and consumption of industrialized countries exist, studies concerning energy in developing nations, especially taking into account the importance and place of traditional fuels, have either not been made or have begun only recently. Since energy shortcomings promise to have serious economic, political and social consequences, energy planning should constitute the most important aspect of overall development planning in developing countries. In the light of the proposed transition to a low carbon energy market, the role of future energy sources depends on, among other factors, their cost, technical potential for capacity,

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availability of good sites and the need for energy storage or load matching [1].

Fossil fuels account for over 80.3% of the primary energy consumed in the world, and 57.7% of that amount is used in the transport sector. This way, it is possible to conclude that fossil fuels are responsible for the emission of a significant amount of pollutants in the atmosphere, including greenhouse gases (GHG). The intensive and low-efficient use of fossil fuels for supplying humans' energy needs over the past century reduced its reserves considerably, resulting in the prognosis of its exhaustion within the next decades. This situation is causing a rise in the prices, bellicose conflicts, making some governments considerably concerned towards assuring their energy security. There is a unanimous opinion that says that the era of cheap energy is long gone [2].

Renewable energies are an important factor for the strengthening of the regional development. However, there are many challenges facing the efforts to increase renewable energy use, which have to be understood and properly translated into a comprehensive regulatory framework. The first and foremost barrier for higher renewable energy penetration into energy systems lies in their high-up front costs and related insufficient cost effectiveness. Thus, it is necessary to introduce financial support mechanism and favorable promotion schemes, especially ones that will attract private financing into energy sector and in such manner reduce the financial burden on the state budget [1].

The global industry expanding new renewable energies is now an investment on the order of $30 billion a year. This has made the new renewable industry a significant market player in some countries. Issues of market shares and market power are becoming increasingly significant, attracting the attention of traditional market players.

The Autonomous Province of Vojvodina is an autonomous province in Serbia, containing about 27% of its total population according to the 2002 Census. It is located in the northern part of the country, in the Pannonia plain. Vojvodina is an energy-deficient province. The indigenous reserves of oil and gas are limited and the country is heavily dependent on the import of oil. The oil import bill is a serious strain on the country's economy and has been deteriorating the balance of payment situation. The country has become increasingly more dependent on fossil fuels and its energetic security hangs on the fragile supply of imported oil that is subject to disruptions and price volatility [3–5]. Hydropower, biomass, biogas, biofuels, wind power, solar energy and geothermal energy are the major resources to provide Vojvodina with most of its renewable energy in the future [6–9]. In this study, the policy, market conditions and food security of biomass energy sources are assessed for supplying the future needs of Vojvodina.

2. Renewable energy policy

Energy is recognized as a crucial element in a country development process. Energy constitutes one of the main inputs for economic and social development. In line with the increasing population, urbanization, industrialization, spreading of technology and rising of wealth, energy consumption is increasing. Energy consumption and consequently energy supply at minimum amount and cost is the main objective, within the approach of a sustainable development that support economic and social development and that have destructive impact on the environment at the minimum level. Vojvodina's energy policy is based on the following items: meeting long-term demand using public, private and foreign capital; privatization activities, especially accelerating privatization activities, in the energy sector; taking into consideration supply costs of energy imports, especially oil and natural gas; ensuring optimum development of all the indigenous energy sources; ensuring sustainable operation of the energy utilizations; ensuring rational use of total energy sources; ensuring environmentally sound sustainable energy development programs causing minimum damage to the environment; meeting demand as much as possible through domestic resources; diversifying energy supplies and avoiding dependence on a single source or a country; adding new and renewable sources (geothermal heat, solar, wind, etc.) as soon as possible to the energy supply system; ensuring sufficient, reliable and economic energy supplies on time; ensuring energy security of supply; implementing measures for energy efficiency; planning energy research and development activities to meet requirements for increasing energy demands; minimizing losses in energy production, transmission, distribution and consumption in the country; protecting the environment and public health in the production of energy.

As basic strategy, improvement of domestic production by increasing efficiency of plants by rehabilitation, diversification of energy sources to secure fuel supply, accelerating the existing construction programs, initiation of new investments are chosen to achieve these energy policies. As Government's financial resources are not enough to achieve these objectives, accelerating of private investments is essential.

3. Renewable market conditions

Before looking at the likely economic performance of the different technologies, it is necessary to consider the characteristics of each and the impact that they may make on the energy market. Two important market conditions relate to (i) overall liberalization of the market, and (ii) the mechanisms that are applied to reflect concerns about energy supply security, industrial competitiveness, and environmental protection.

Biomass energy includes fuel wood, agricultural residues, animal wastes and other fuels derived from biological sources, is used by approximately half of the world's population as cooking and/or heating fuel and currently accounts for about 14% of world energy consumption. Biomass is the main source of energy for many developing countries, providing more than 90% of the energy supply in some developing countries.

The utilization of renewable sources in total energy consumption of Vojvodina currently amounts to less 1%, that is less than 280 GWh/year. Through a combination of methods for introducing new and renewable sources, systematic application of measures for increased energy efficiency as well as utilization of new technologies, the percentage of unconventional energy sources in total energy consumption of Vojvodina can be increased to up to 20% [3].

3.1. Biofuels

Within renewable energy sources, only the amounts of biofuel–biodiesel that are produced in the factory Vctoria Oil, Šid which has a capacity of 100 MT of biodiesel per year and which has started production in the middle of 2007 are quantified. The planned production of biodiesel in 2008 is 0.07 MT (0.07 Mtoe), which is 133% more than in 2007 (0.03 MT). Available quantity of biodiesel for final consumption amounts to 0.069 MT (0.07 Mtoe), which is 138% more than in 2007. It is planned that 0.042 MT (0.042 Mtoe) of that amount would be utilized in traffic, which is 133% more than in 2007 (0.018 MT), while 0.027 MT (0.027 Mtoe) of that amount is planned to be utilized in agriculture, which is an increase of 146% compared to 2007 (0.011 MT).

3.2. Biomass

Waste biomass is utilized from agrocomplexes for heating purposes in individual rural households, while in recent times the

use of waste biomass in industry has also been noted (e.g. industrial steam generator on waste wood "Tarket" - Bačka Palanka, steam generator on waste biomass in "Mitrosrem" u Sr. Mitrovici, on straws of wheat). Many steam generators on waste biomass were produced from the industrial process in oil refineries (raw material was sunflower husk in Sombor and Šid). Comminute and pelletizing is used sparingly, except in individual cases. There is no cogenerative facility on biomass.

3.3. Waste

Generally the communal waste is not currently used for energy purposes.

3.4. Wind

Measuring has begun in the following locations: Inđija-Koševo, Deliblato, Pančevo, Kanjiža, Irig, Kovin, Bela Crkva, Šid, Titel, which is performed mainly by foreign investors. Provincial department for energy and mineral raw materials finances manufacturing of WIND-atlases, and the Executive body of AP Vojvodina established a Council for utilization of wind energy.

3.5. Geothermal energy

In Vojvodina 75 hydrothermal boreholes have been drilled with an average production of 9.5 L/s, average outgoing temperature of 48.8 °C, the total thermal potential (strength) of all boreholes which can currently be exploited (have built systems) amounts to about 54 MW, of which 19 MW or 26% is utilized, mainly for heating purposes in balneologies and tourism.

3.6. Solar energy

There is a significant potential, which per insolation has 20–30% more intensity than the European average. There are 267 sunny days, and average solar energy is about 1000 kWh/m^2. The thermal effect of the sun across thermal solar collectors, is used on smaller individual objects, while usage in hospitals and tourist objects is also noticable.

3.7. Hydropotential

There are no small hydroelectric power plants that have been built from 12 possible locations on the canal DTD and dam on Tisa. The total potential installed strength is 20 MW, with a potential yearly production of about 95 GWh of electrical energy (Table 1).

It is essential that the production and utilization of energy from renewable sources be defined and encouraged, for which significant financial resources are required (Table 2).

Table 1
Potential production of thermal and electrical energy.

Renewable sources	Total potential (ktoe/year)	Thermal energy (TJ/year)	Electrical energy (GWh/year)
Biomass (1/3 solid)	768	35,000	360
Biogas	3	90	20
Biofuel	150	–	–
Wind power	65	–	750
Geothermal energy	22	1,800	–
Communal waste	158	6,000	56
Small hydroelectric plants	7.7	–	90
Larger hydroelectric plants	85	–	990
Solar energy	34	1,400	–

Table 2
Required financial resources for encouraging production of energy from renewable sources of energy until 2012 in Vojvodina.

Renewable sources	Required financial resources (million €)
Biomass—plants power 1400 MW (thermal energy)	200
Biogas—plants power 2.5 MW	
Bovine farms	7
Swine farms	6.3
Biofuels—150,000 T (transport)	150
Wind energy—300 MW (electrical energy)	300
Geothermal energy (thermal energy)	46
Small hydroelectric plants (electrical energy)	20
Waste (communal waste)—15 MW (electrical and thermal energy)	30
Solar energy—80,000 households per 4 m^2 (hot water)	104
Total	863.3

Provincial department for energy and mineral raw materials coordinates all programs and projects regarding the utilization of renewable sources of energy in Vojvodina. Vojvodina is open to all investment from domestic and foreign investors for building new capacities with regard to new renewable energy sources and increasing of energy efficiency.

4. Applications barriers of biomass energy in Vojvodina

The major barrier to the use of renewable energy is the fact that all such sources have low energy intensity per unit area. Four major barriers have to be overcome to increase the use of renewable energy in the market. These are economic barriers, cost of technologies, financing issues and scientific and technical barriers. Each of these barriers is given below.

Economic barriers—economic barriers are assumed to be the primary barriers to a broader introduction of renewable energy technologies. These factors include the cost of renewable technologies and their resultant electricity; difficulties in obtaining financing for renewable technologies, the failure to include externalities in the cost of generating electricity; and the money and interests already investment in existing infrastructure and technology.

Cost of technologies—while renewable energy technologies require no fuel and their operation and maintenance cost (O&M) cost are generally low, the upfront capital cost of renewable is relatively high per unit of capacity installed. These high capital cost is considered to be one of the major barriers to greater use of renewable technologies. Higher production costs of renewable energy might be attributed to two main aspects. First, renewable energy has higher capital costs than fossil-fuelled systems. This might reduce the access to funding, i.e., higher financial risks. Besides, most of the tax systems tend to penalize capital-intensive renewable energy investments. Second, external environmental and social costs of fossil fuels have been ignored by markets. These costs include pollution, greenhouse gas emissions, and even military expenditures to defend overseas oil supplies.

Financing issues—another critical factor in the development and use of renewable technology is financing. Much of the cost of generating electricity with oil, coal and gas is the cost fuel; this investment is made and recouped in relatively small increments over many years. With renewable technologies, however, the initial capital outlay is large and must be recovered slowly over a period of many years, making it difficult for renewable to attract capital. Thus, investment in renewable energy technologies is discouraged at the outset.

Scientific and technical barriers are also blamed for stalling large-scale adoption of renewable energy technologies. Policy environments: one of the most significant policy barriers for renewable links back to economic factors; the impact of government R&D funding and subsidies on the cost of various resources and technologies. Successful commercialization of renewable energy sources has been hindered by competition in the electricity markets, due to barriers such as [10]: high capital cost associated with building the necessary infrastructure to promote clean energy sources; initial transactions cost associated with reaching environmentally conscious consumers; the inability of clean energy technologies to penetrate the electricity markets, despite their long-term cost-effective power technologies; failure to quantify the economic development benefits and national economic security provided by renewables.

For heat and electricity production, there are existing projects, mainly using combustion. This is a commercial technology, in which the Vojvodina has leading technology players, and the technology and market risk are relatively low. Policy support has been and is directed at combustion systems, but has tended to favor potentially more efficient and cleaner advanced technologies such as gasification and pyrolysis. Innovation is focused on the development of these technologies, which are at the demonstration stage but are commercial in niche markets. For transport fuel production, there is some Vojvodina R&D, but little commercial activity.

The biomass fuel cycle has near-zero net emissions of CO_2 since CO_2 are fixed by the plants as they grow. The land area to replace a significant portion of the electricity currently generated by coal limits the use of biomass. In case of biomass, the following links are clearly weak: resource compatibility; user support; needs assessment; using wastes for fuel may degrade soil quality; sugar plantations, sawmills, etc. often owned by rural elite; could results in competition between land uses for feed/fuel.

It is difficult to collect large quantities of biomass wastes due to their disperse nature. The availability of some types of biomass is seasonal. In addition annual productions of most biomass fluctuate from year to year depending on climatic conditions. Biomass is also difficult and costly to transport. The costs of biomass wastes fluctuate widely, depending crop the productions and economic condition.

5. Biomass energy and the environment

The biofuels have been seen by many people as a cleaner way to meet the energy needs in the transport sector. According to Puppán [11] their environmental benefits are shown during the combustion in the engines, given that their emissions of CO_2 correspond to the amount that was sequestrated from the atmosphere during the growth of these plants, resulting in a closed carbon cycle.

It is important to keep in mind that in spite of the advantages that characterize the use of biofuels, their production and end use may have serious environmental impacts such as the use of large amounts of water, the destruction of forests, the reduction in food production and the increase in soil degradation [12].

A useful tool to determine the environmental impact of the biofuels is the life cycle analysis (LCA), i.e., the evaluation of the consumption and impacts in all the stages of the life cycle of the product.

In the case of bio-ethanol, the results of the researches using LCA as an 'integral' tool are contradictory, given that some studies present negative impacts whereas others are more favorable. A study carried out by Blottnitz and Curran [13] presents an assessment of 47 analyses, published along the past few years, which compares bio-ethanol with a conventional fuel using LCA. Most of the analyzed studies assess the net energy necessary for the attainment of the biofuels and the emission of greenhouse gases. Although there are differences in the considerations and limits of the systems, it is possible to reach the following conclusions: (i) attaining ethanol from crops rich in sugars in tropical countries is much more feasible than from grains in temperate regions, but the precautions regarding the use and the extension of the farmland area must be taken; (ii) the attainment of ethanol through hydrolysis and fermentation of ligno-cellulosic residue must be considered.

Different indicators are used to assess the advantages that a certain type of raw material presents in relation to others. One of the used indicators is the replacement potential of fossil fuel, expressed in GJ/ha year, which depends on the type of agricultural material used for the production of ethanol.

Another indicator that is used is based on the relation renewable/fossil energy (output/input) for different biofuels raw materials. It is calculated as the relation between the quantity of renewable energy attained and the quantity of fossil fuel that was consumed in the entire life cycle of production and use of biofuel per unit of product.

This indicator shows whether a fuel can be considered renewable or not. If this indicator is zero, it means that the fuel is not renewable at all and it also does not produce useful energy. If the indicator is 1, the fuel is still considered as non-renewable. An infinite indicator shows that the fuel is absolutely renewable and any value higher than 1 shows that the fuel is renewable up to a certain point.

Pimentel and Patzek [14] show that the indicator renewable/fossil energy relation for the production of ethanol out of corn, grass and wood, which is the case of the USA, is negative, indicating that the renewable energy from ethanol out of these raw materials is lower than the energy supplied by fossil fuels during its production. A study carried out by Hill et al. [15], which considered the ethanol produced out of corn, showed a positive value for this indicator, but the value was only 1.25.

Table 3 presents the values of the renewable/fossil energy relation attained for raw materials used for the production of ethanol in different countries.

It is observed that the ethanol produced out of sugarcane in Brazil presents the best yield in case of a large-scale production in comparison with the other raw materials used in other bio-ethanol producing countries. In the future, the use of ligno-cellulosic residues for the production of bio-ethanol will probably lead to a rise in the renewable/fossil energy relation.

In relation to the environmental impact of biodiesel, there are also different results regarding the energy gain in different studies.

Pimentel and Patzek [14] present unfavorable results for the production of biodiesel out of sunflower and soybeans. The main reasons are the low agricultural yield and the high energy consumption of the process that attains the oil out of these raw materials. Wesseler [16] suggests considering in Pimentel and Patzek's study (2005), the cost of the opportunity in the processing of the raw materials. This way, it is possible to get positive energy balances.

Table 3
Renewable/fossil energy relation for different raw materials for bio-ethanol attainment [13].

Raw material	Country	Renewable/fossil energy relation
Sugarcane	Brazil	7.9
Sugar beet	England	2.0
Corn	USA	1.3
Molasses	South Africa	1.1
Wheat straw	England	5.2
Corn straw	USA	5.2

Table 4
Comparison of the renewable/fossil energy relation for biodiesel attained from different oleaginous plants [17].

Biodiesel raw material	Country	Renewable/fossil energy relation
Rapeseed	Europe	1.7
Soybean	USA	3.2–3.4
Sunflower and rapeseed	Europe	2.4–5.23
Castor	Brazil	2–2.9
Oil palm	Brazil	4.7
Oil palm	Colombia	4.86–5.95

The analyzed studies show that depending on the type of vegetable crop that will be used and the method of growth and harvest, there must be positive and negative effects on the use of the soil, quality of water, and quantity of net emission to the environment.

Table 4 presents a summary of the renewable/fossil energy relation for the biodiesel life cycle from several raw materials in different countries.

It also shows that it is possible to observe that the renewable/fossil energy relation for oil palm biodiesel is higher in comparison with the one attained for other cultures. The main reason for that is the high productivity of the oil palm, which is nearly eight times higher than the other plants. The culture of oil palm also produces a larger amount of biomass, which aggregates value to the industrial process and to the agricultural production, with the possibility of using it as fuel for steam and electricity generation.

The greatest life cycle energy consumption input fraction corresponds to the one related to the methanol used for the transesterification process, followed by the agriculture one. The replacement of methanol for sugarcane bio-ethanol will allow the attainment of values in the renewable/fossil fuel relation above 9.0 [17]. LCA studies must consider also the type of pre-existing ecosystem, the carbon balance and co-products' energy allocation.

Therefore, the selection of the appropriate type of crop for a certain region may reduce the associated environmental impact, once it is possible to reduce the need to use fertilizers, water and the pollution related to the process. Fossil fuels are used for the production of raw materials, transport and for it conversion into biofuels.

6. Biomass energy and food security

Poverty in rural areas and the lack of programs and funding for agricultural development are the most important causes of nourishment insecurity; conflicts, terrorism, corruption and environmental degradation also contribute significantly towards the problem [18]. Food production in the world has increased substantially. However, the insufficient household and national income, as well as natural or man-caused catastrophes have prevented the population from satisfying their basic nourishment needs.

In 1992, there was a meeting in Rome (World Food Summit—WFS) involving the government of 180 countries. During this meeting the countries claimed their will to reduce the number of undernourished people in the world by the year 2015 to half of the number presented in 1990. An analysis carried out 10 years later showed that the results were not very satisfactory. Within the period between 2001 and 2003 the FAO estimated a number of 854 million undernourished people in the world, out of which 820 million were in the developing countries, 25 million in the transition countries and 9 million in the industrialized countries. In 2006, in comparison with the period between 1990 and 1992, the number of undernourished people in developing countries had been reduced in 3 million. This number lies within the levels of statistic errors and does not reflect a reduction in the population that suffers from hunger and malnutrition in the world [19].

Among the causes that make it difficult to reach the goal proposed by the WFS are the armed conflicts and natural disasters. In some countries, where there are no conflicts, it is possible to observe a poor agricultural and economic development together with high rates of population growth.

Cereals are the most important source of nourishment in the world [20], either for direct human consumption or indirectly, for feeding livestock. Therefore, variation in the availability and prices of cereals may be crucial for the world's food supply. The use of farmland and grains that could be consumed by humans for biofuel production is already sending warning signals in some places of the world.

The USA is responsible for 70% of the corn world export. As more and more distilleries are being built there for ethanol production, the concern in soaring up, both from the food manufacturers that depend on these grains, and for countries importing food and oil simultaneously. As the oil prices go up, the production of biofuels out of agricultural products is more profitable and, therefore, there is a risk of the price of a raw material used for biofuel production to increase beyond the price offered by the food industry, then, this raw material will be converted into fuel. In Europe, the production of biodiesel out of vegetal oil led the margarine producers to request help for the European Parliament, given the inequality of the prices that they had to compete with the biodiesel refineries [21].

Recently, The World Food Programme (WFP) expressed its concern about the rise in the price of food over the past 5 years. Among the causes said to be related to this increase are: some crops were affected by climatic conditions in some areas, reduction of the reserves of some grains such as wheat, increase in the food demand coming from India and China, rise in the oil rices and, finally, the growing use of biofuels produced out of corn and sugarcane.

In relation to this issue, UN experts state that biofuels such as ethanol can help to reduce global warming and generate jobs for poor people from rural areas, but they also warn that the benefits could be eliminated by serious environmental problems and by the rise in the food prices if the growth of the biofuel industry happen inordinately.

The creation and establishment of regulating policies that guarantee the control of the land destined to the production of biofuels and their origin are of the utmost importance, trying to avoid a larger increase in the degradation of the environment by the accelerated growth of this market. Every year 100,000 km^2 of land lose their vegetation, are degraded or become deserts. These facts have direct consequences towards the changes in the environment and the climatic conditions of the planet [22].

Given the growing concerns of the society in relation to the impacts on the environment and food security, a series of measures are being suggested by non-governmental organizations such as WWF, European countries and governmental sectors in Brazil and Colombia.

One example is the proposal to create an ecological stamp or another certification mechanism for the companies dedicated to the production of biofuels in Brazil. This would allow an appropriate regulation regarding the growth of this sector. For only those fuels that have the environmental certification would be allowed to be commercialized in the market.

With the implementation of these measures, an appropriate regulatory mark will be established for the future growth and expansion of crops destined to the attainment of biofuels, hence reducing the environmental risks related to their production and assuring the necessary land quotes for food production.

The Crisis blew off on everybody's faces, because we were unable to foreseen the danger. The United Nations are now claiming – maybe a little too late – for solutions, but it is unavoidable to have in mind that the present situation is the result of all the above mentioned recent causes simultaneously, added to hundreds of years of unfair distribution of wealth.

So, it is obvious that to reach real and transcendental solutions to the crisis it is necessary to transactionalize the human solidarity by: recognizing the real causes that drove to the present situation; facing the problems with a responsible and humanistic approach; ensuring an effective and fair international collaboration to increase food production in developing countries—this is called a new "green revolution"; being wise enough not to drive a confrontation between energy, food and the environment; getting an integral wisdom that overcomes selfishness and the temptations of partial and regional solutions.

7. Conclusions

Renewables can play a significant role in satisfying the future energy need in Vojvodina. The present renewable market conditions, for instance in Vojvodina, may not be a good guide to the future since the wholesale price of electricity is remarkably high at present, corresponding to the gas and oil price. We are examined some reasons why many renewable energy projects have failed in Vojvodina: many renewable energy projects in country used premature technologies which were still under-research; the design of many projects did not allow sufficient, long-term maintenance; many renewable energy projects were either demonstration projects, or for other reasons not replicated; renewable energy technologies are often simply too expensive to be used in country, where financial resources are limited.

The effectiveness comes from the uniqueness of renewable energy technologies with respect to following aspects: being a low cost technology; modern energy services must be meet multiple social needs; renewable energy technologies are the key element to overcome the stalemate in international climate negotiations; energy policy markers have to make choices, all electricity generating options have environmental, social, and economic consequences, and the optimum decision has to be made in particular situations.

From the whole panoramic view for the biofuels production, market and consumers showed above, it is clear that to qualify and to judge biofuels in a generic way conducts to a very notable mistake. The possibilities for use landfarm in each country, the assessment of the food security for the population, the goals for improving air quality in the main cities and the determination of raw materials costs depends (between others factors) of local economies, regional political constraints and mainly of the level of development reached by each country. Besides, not all locations have the required environmental potential (sun radiation, soil fertilization, water supply) available at cost-based scale.

When the impact of biofuels on food security is assessed, it is important to make a distinction between their production out of cereals or oleaginous plants, which are not appropriate for human consumption. An international and regional analysis of the problem is mandatory in order to define whether there are local conditions to implement similar programs. On the other hand, it is necessary to consider the impact of other factors such as the high prices of oil, armed conflicts, natural disasters and soil degradation.

A regulatory mark and certification mechanisms that establishes the limits regarding the use of land, the environmental impacts and that would encourage the improvement of the life conditions of the rural workers involved with biofuel programs are also necessary.

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